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An Overview of Triglyceride-to-HDL Ratios and LDL Levels in Patients with Coronary Heart Disease at Royal Prima Hospital, 2024–2026

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Abstract

Coronary heart disease (CHD) is closely associated with lipid metabolism disturbances involving triglycerides, high-density lipoprotein (HDL), and low-density lipoprotein (LDL). The triglyceride-to-HDL (TG/HDL) ratio provides an additional indicator of metabolic abnormalities relevant to cardiovascular risk. This study aimed to describe triglyceride, HDL, and LDL levels and examine the relationship between TG/HDL ratio categories and LDL categories among patients with CHD at Royal Prima Hospital Medan during 2024–2026. An observational analytic cross-sectional study was conducted using secondary medical-record data from 96 CHD patients selected through simple random sampling. The TG/HDL ratio was calculated by dividing triglyceride by HDL concentration and classified as normal (≤ 2.197) or high (> 2.197), while LDL was classified as normal (< 130 mg/dL) or high (≥ 130 mg/dL). Descriptive analysis and Pearson Chi-Square testing were performed. The mean triglyceride, HDL, and LDL levels were 135.49, 50.53, and 140.20 mg/dL, respectively, with a mean TG/HDL ratio of 2.912. A high TG/HDL ratio was identified in 69 patients (71.9%), while 46 patients (47.9%) had high LDL levels. Pearson Chi-Square analysis showed no statistically significant association between TG/HDL ratio category and LDL category ($\chi^2=1.782$; $df=1$; $p=0.182$). These findings indicate that a high TG/HDL ratio was prevalent among CHD patients, whereas TG/HDL and LDL categories did not show a statistically significant relationship in the observed population.

Keywords: Coronary Heart Disease, HDL, LDL, Lipid Profile, Triglyceride-To-HDL Ratio.



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INTRODUCTION

Cardiovascular disease has remained one of the leading causes of death worldwide for more than three decades, with its burden continuing despite substantial advances in prevention, diagnostic technologies, and therapeutic strategies. Global estimates indicate that cardiovascular disease accounted for approximately one-third of all deaths in 2021, corresponding to around 20.5 million deaths, while coronary heart disease (CHD) contributed approximately 9.1 million deaths in 2019, underscoring the continuing magnitude of coronary pathology at the population level (Di Cesare et al., 2024). Coronary heart disease develops primarily through pathological changes in the coronary arteries that restrict myocardial blood flow, with atherosclerosis representing a central biological process involving lipid accumulation, vascular inflammation, endothelial dysfunction, and progressive plaque formation. Atherosclerotic lesions tend to develop preferentially in vascular regions exposed to disturbed haemodynamic conditions, including areas characterized by altered endothelial shear stress, which can influence plaque progression and composition (Candreva et al., 2024). Contemporary perspectives on coronary atherosclerosis further emphasize that clinical manifestations depend not only on the extent of arterial narrowing but also on plaque characteristics and biological instability that may precipitate acute coronary events (Siasos et al., 2022). Such developments have expanded cardiovascular research from a predominantly anatomical understanding of coronary obstruction toward a more integrated assessment of lipid, metabolic, inflammatory, and vascular determinants of disease.

Indonesia faces a substantial health and economic burden from cardiovascular disease, with heart disease representing a major component of catastrophic disease within the national health-care system. Data reported by the Ministry of Health of the Republic of Indonesia indicate that heart disease accounted for 22,550,047 cases or 68.25% of all catastrophic disease cases in 2024, accompanied by health-care expenditure of approximately IDR 19.25 trillion or 51.63% of total catastrophic disease

expenditure (Kementerian Kesehatan Republik Indonesia, 2024). The magnitude of these figures illustrates that CHD represents more than an individual clinical problem because its consequences extend to health-care utilization, financial resources, and the broader management of chronic cardiovascular risk. Preventive strategies therefore require reliable identification of modifiable biological characteristics that can be assessed efficiently within routine clinical practice. Lipid abnormalities are particularly relevant because disturbances in circulating lipoproteins contribute to atherogenesis while also interacting with glucose metabolism, adipose-tissue activity, and other metabolic pathways. Clinical evidence from Indonesia has shown variation in lipid profiles among patients with CHD, indicating that lipid characteristics should be interpreted within the specific clinical population rather than assumed to follow a uniform pattern across different settings (Anata & Yasmin, 2025). Such population-specific evidence is important for understanding whether conventional and emerging lipid indicators provide complementary information for patients who have already developed coronary disease.

LDL-C has traditionally received substantial attention in CHD prevention and management because LDL particles play a central role in the development and progression of atherosclerotic cardiovascular disease and constitute a principal target of lipid-lowering therapy. Contemporary cholesterol-management guidelines consequently place LDL-C reduction at the centre of strategies designed to reduce cardiovascular risk and prevent recurrent events (Grundy et al., 2019). Nevertheless, LDL-C alone does not necessarily capture the broader metabolic abnormalities that may accompany coronary disease, particularly when triglyceride-rich lipoprotein metabolism and HDL-related dysfunction are present. Triglyceride metabolism is closely connected with fatty-acid mobilization and adipose-tissue lipolysis, processes that influence the availability and distribution of lipid substrates throughout the body (Cho et al., 2023). HDL-related abnormalities may also extend beyond absolute HDL-C concentration because metabolic disturbances can modify HDL composition and functionality, potentially altering its role in lipid transport and vascular protection (Zhang & van der Vorst, 2024). These biological considerations have encouraged interest in composite lipid indicators such as the triglyceride-to-HDL cholesterol ratio (TG/HDL-C), which may reflect metabolic disturbances that are less apparent when LDL-C is considered independently. The growing use of TG/HDL-C therefore reflects an attempt to complement conventional lipid assessment with an indicator that integrates two components of the atherogenic metabolic profile.

The relevance of TG/HDL-C is particularly apparent in relation to insulin resistance, a metabolic condition that is closely associated with dyslipidemia and cardiovascular disease. Insulin resistance can promote a cluster of pathological processes involving impaired glucose regulation, altered lipid metabolism, endothelial dysfunction, inflammation, and vascular abnormalities, thereby creating biological conditions that facilitate cardiovascular disease progression (Kosmas et al., 2023). Elevated TG/HDL-C has consequently been investigated as a surrogate indicator of insulin resistance, although its interpretation remains dependent on the characteristics of the population being studied (Baneu et al., 2024). Evidence from an Indonesian population at risk of metabolic syndrome has also examined the relationship between dietary patterns, TG/HDL-C, and cardiovascular risk, indicating the relevance of this ratio within the local metabolic context (Hayat et al., 2024). Clinical research conducted in Medan has further reported an association between TG/HDL-C and coronary lesion severity among patients with acute myocardial infarction, extending the potential relevance of the ratio from metabolic assessment toward coronary disease characterization (Sinaga et al., 2023). Recent Indonesian research examining non-traditional lipid profiles and obstructive coronary artery disease similarly reflects increasing interest in lipid indicators beyond conventional LDL-C measurements (Munita et al., 2025). Collectively, these findings suggest that TG/HDL-C may provide clinically meaningful information, although its relationship with conventional LDL-C categories among patients with established CHD remains insufficiently characterized.

Interpretation of TG/HDL-C remains complicated by substantial variation in proposed thresholds and by differences in metabolic characteristics across populations. Research among middle-aged and elderly Taiwanese individuals identified a TG/HDL-C cut-off of 2.197 for indicating insulin resistance, supporting the relevance of an Asian-specific threshold rather than unrestricted application of values derived from other populations (Yeh et al., 2019). The relationship between lipid abnormalities and cardiovascular outcomes may also be modified by endocrine and metabolic conditions, including hypothyroidism, which can influence lipid synthesis, clearance, and circulating

lipoprotein concentrations (Su et al., 2022). Existing coronary studies have examined LDL-C according to coronary disease severity and have reported differences in LDL-C levels across clinical categories, but such findings primarily address conventional lipid levels rather than the relationship between LDL-C and TG/HDL-C within the same CHD population (Tanaka et al., 2023). Research examining LDL/HDL-C has similarly demonstrated relationships with coronary lesion severity, yet LDL/HDL-C represents a different biological construct and cannot be treated as equivalent to TG/HDL-C (Hashmi et al., 2024). Recent evidence from Indonesia has reported associations involving TG/HDL-C and LDL/HDL-C with coronary artery disease, but the available literature remains heterogeneous with respect to study populations, outcomes, lipid classifications, and clinical settings (Susila et al., 2025). This heterogeneity creates an empirical gap concerning whether TG/HDL-C categorization corresponds systematically with LDL-C categorization among patients with established CHD receiving routine hospital care. Clarifying this relationship is clinically relevant because patients with similar LDL-C concentrations may exhibit substantially different triglyceride and HDL-C profiles, potentially indicating different underlying metabolic characteristics.

The present study is positioned within this developing literature by examining conventional and composite lipid indicators together in a defined population of patients with CHD. Secondary data obtained from medical records of patients with CHD at Royal Prima Hospital Medan during 2024–2026 are analyzed using an observational analytic cross-sectional design, allowing lipid measurements recorded during the same period of clinical observation to be evaluated without intervention. The analysis describes TG/HDL-C and LDL-C levels and examines the statistical relationship between their respective categories within the study population. A TG/HDL-C cut-off of 2.197 is adopted because the threshold originates from research involving an Asian population, while LDL-C is categorized according to the specified NCEP classification in which values below 130 mg/dL are regarded as the reference category. The study is intended to address the limited hospital-based evidence concerning the correspondence between TG/HDL-C and LDL-C among patients with established CHD, particularly within an Indonesian clinical setting. Theoretically, the research contributes to the discussion of lipid assessment by examining whether a composite ratio reflecting triglyceride and HDL-C characteristics provides a distinct or related profile to conventional LDL-C categorization. Methodologically, the study contributes contemporary real-world evidence based on routinely recorded laboratory data and provides a basis for subsequent investigations incorporating additional metabolic and clinical variables into more comprehensive assessments of lipid-related characteristics in CHD.

RESEARCH METHODS

This study employed an empirical, observational analytic design with a cross-sectional approach using secondary data obtained from the medical records of patients with coronary heart disease (CHD) at Royal Prima Hospital Medan during the 2024–2026 observation period. The study population comprised all patients diagnosed with CHD who received inpatient or outpatient care during the study period, with eligible participants required to have lipid-profile examination records containing triglyceride (TG), high-density lipoprotein (HDL), and low-density lipoprotein (LDL) measurements obtained at hospital admission or the initial clinical visit. The inclusion criteria were patients with a documented CHD diagnosis and complete TG, HDL, and LDL laboratory data, whereas records with incomplete lipid measurements, duplicated records, or laboratory information that could not be reliably interpreted were excluded from the analysis. The assessment of TG and HDL was relevant because abnormalities in these lipid components are associated with metabolic disturbances and cardiovascular risk, particularly insulin resistance (Baneu et al., 2024). The minimum sample size was determined using a single-proportion estimation formula with a 95% confidence level, Z_{α} of 1.96, a precision level of 10%, and an assumed population proportion of 0.50, resulting in a minimum sample requirement of 96 patients. Probability sampling using simple random sampling was then applied by randomly selecting eligible patient records from the sampling frame until the required sample size was achieved, while the use of lipid measurements was consistent with the established importance of lipid assessment in cardiovascular disease management (Grundy et al., 2019).

Table 1. Operational Definitions

No.	Variable	Operational Definition	Data Scale	Measurement / Category
1	Triglyceride (TG)	Blood triglyceride concentration in patients (mg/dL)	Ratio	TG value (mg/dL)
2	HDL (High-Density Lipoprotein)	Blood HDL cholesterol concentration in patients (mg/dL)	Ratio	HDL value (mg/dL)
3	LDL (Low-Density Lipoprotein)	Blood LDL cholesterol concentration in patients (mg/dL)	Ratio	LDL value (mg/dL)
4	TG/HDL Ratio	Ratio of the patient's triglyceride (TG) concentration to HDL concentration	Ratio	TG/HDL ratio value
5	Age	Patient's age	Ratio	Age in years
6	Sex	Patient's sex	Nominal	Male / Female
7	TG/HDL Category	Classification of the TG/HDL ratio based on the study cut-off	Nominal	Normal (≤ 2.197) / High (> 2.197)
8	LDL Category	Classification of LDL concentration based on the study cut-off	Nominal	Normal (< 130 mg/dL) / High (≥ 130 mg/dL)

The research instrument consisted of a structured data-extraction sheet used to record age, sex, TG concentration, HDL concentration, and LDL concentration from eligible medical records, with all extracted information coded before statistical analysis. The TG/HDL ratio was calculated by dividing the TG concentration by the HDL concentration for each patient, with a value of ≤ 2.197 categorized as normal and a value of > 2.197 categorized as high based on the Asian population threshold reported by Yeh et al. (2019). LDL concentration was categorized as normal when < 130 mg/dL and high when ≥ 130 mg/dL according to the classification established in the study. Univariate analysis was conducted to describe participant characteristics and the distribution of each study variable, with categorical data presented as frequencies and percentages and numerical data presented as means and standard deviations for normally distributed variables or medians with minimum–maximum values for non-normally distributed variables. Bivariate analysis examined the association between TG/HDL categories and LDL categories using Pearson's Chi-Square (χ^2) test, with statistical significance determined at $\alpha = 0.05$ and $p < 0.05$ interpreted as a statistically significant association, consistent with the broader use of lipid-ratio indicators in studies of coronary artery disease (Susila et al., 2025). The null hypothesis stated that no statistically significant association existed between TG/HDL categories and LDL categories among patients with CHD, while the alternative hypothesis stated that a statistically significant association existed between the two variables, and ethical approval was obtained from the relevant institutional ethics committee before data collection with patient confidentiality, de-identification, restricted data access, and research-only use of medical records maintained throughout the study.

RESULTS AND DISCUSSION

Triglyceride Levels in Patients with Coronary Heart Disease

Triglycerides are an important component of the lipid profile and are closely involved in the metabolic processes underlying cardiovascular disease. In patients with coronary heart disease (CHD), triglyceride concentrations may reflect disturbances in lipid transport, energy metabolism, and the broader metabolic environment associated with atherosclerotic disease. The clinical relevance of triglycerides has increased as cardiovascular risk assessment has expanded beyond isolated measurements of LDL cholesterol. Dyslipidemia in patients with diabetes and other metabolic disorders may involve increased triglyceride concentrations accompanied by alterations in other lipoprotein fractions, making triglycerides a relevant component of comprehensive lipid assessment (Goldberg, 2022). The Indonesian Ministry of Health also emphasizes cardiovascular disease prevention through the identification and management of modifiable risk factors, including metabolic and lipid-related

abnormalities (Kementerian Kesehatan Republik Indonesia, 2024). Assessment of triglyceride levels among patients with established CHD can consequently provide useful information regarding the metabolic characteristics of the clinical population.

The descriptive findings provide an overview of triglyceride concentrations among 96 patients with CHD treated at Royal Prima Hospital during 2024–2026. The mean triglyceride concentration was 135.49 mg/dL, with a standard deviation of 30.579 mg/dL. The median value was 146.00 mg/dL, while the observed values ranged from 61 to 180 mg/dL. The difference between the mean and median suggests that the distribution was not completely symmetrical, although these descriptive statistics alone cannot establish the underlying distribution pattern. The relatively broad range indicates that patients with CHD in this sample did not exhibit a uniform triglyceride profile. Similar attention to lipid-profile characteristics among Indonesian patients with CHD was reported by Anata and Yasmin (2025), who examined lipid parameters among patients treated at Gatot Soebroto Central Army Hospital. These findings support the importance of describing individual lipid components rather than relying exclusively on a single lipid marker when characterizing patients with CHD.

Table 2. Description of Triglyceride Levels

Variable	n	Mean (mg/dL)	SD	Median (mg/dL)	Minimum (mg/dL)	Maximum (mg/dL)
Triglyceride (TG)	96	135.49	30.579	146.00	61	180

The values presented in Table 2 indicate that triglyceride concentrations in the study population were centered around the mid-130 mg/dL range, while the median of 146.00 mg/dL indicates that at least half of the observations were at or below this value. The standard deviation of 30.579 mg/dL demonstrates meaningful interindividual variation in triglyceride concentrations, suggesting that the CHD population was metabolically heterogeneous. The minimum concentration of 61 mg/dL and maximum concentration of 180 mg/dL further demonstrate that the sample included patients with substantially different triglyceride profiles. The mean concentration itself does not indicate that all patients had clinically similar lipid conditions because individual values varied considerably across the observed range. A comparable emphasis on lipid-profile variation is relevant to CHD populations because lipid abnormalities may differ between patients according to metabolic status, comorbidities, and treatment exposure (Anata & Yasmin, 2025). The descriptive pattern provides a basis for examining the triglyceride-to-HDL ratio in subsequent analysis because triglyceride concentration becomes more informative when interpreted together with HDL rather than as an isolated parameter.

From a metabolic perspective, triglyceride concentrations are influenced by the balance between lipid uptake, storage, mobilization, and hepatic lipoprotein production. Adipose tissue lipolysis releases fatty acids that can subsequently enter circulation and contribute to hepatic lipid metabolism, particularly when metabolic regulation is disturbed (Cho et al., 2023). Insulin resistance is particularly relevant because impaired insulin signaling can alter adipose tissue lipid handling and promote an unfavorable circulating lipid pattern (Kosmas et al., 2023). The relationship between triglycerides and insulin resistance also provides a biological basis for considering triglycerides together with HDL in cardiovascular risk assessment. Baneu et al. (2024) identified the TG/HDL ratio as a surrogate biomarker associated with insulin resistance, indicating that triglyceride concentrations should be interpreted within a broader metabolic context. This mechanism is relevant to patients with CHD because insulin resistance can coexist with abnormalities in lipid metabolism and contribute to an atherogenic metabolic environment.

The observed triglyceride pattern can also be interpreted alongside evidence concerning cardiovascular risk and coronary atherosclerosis. Hayat et al. (2024) demonstrated that the triglyceride-to-HDL ratio has relevance to cardiovascular risk among individuals with metabolic syndrome risk, reinforcing the importance of considering triglyceride concentrations in relation to other lipid parameters. Evidence from Indonesian clinical populations has similarly linked non-traditional lipid measures with the extent of coronary disease, suggesting that lipid relationships may provide information beyond conventional isolated measurements (Munita et al., 2025). Sinaga et al. (2023) specifically examined the association between the TG/HDL ratio and coronary lesion severity among patients with acute myocardial infarction at Adam Malik Hospital in Medan. These findings indicate

that triglyceride-related measures can reflect metabolic characteristics that are clinically relevant to coronary pathology. Nevertheless, the triglyceride concentration observed in the present sample should not be interpreted independently as a direct measure of coronary lesion severity because the current analysis is descriptive and does not establish a causal relationship.

Another consideration is that triglyceride concentrations can be modified by factors occurring before or during clinical assessment, including dietary intake, metabolic disease, and lipid-lowering treatment. Dietary fat composition can influence cardiovascular lipid profiles, although its effects depend on the specific type of fatty acid and the overall dietary pattern (Sacks et al., 2017). Diabetes and insulin resistance may also alter triglyceride metabolism, making metabolic status an important contextual factor when interpreting triglyceride measurements (Goldberg, 2022). In addition, the triglyceride value recorded in a medical record represents a measurement at a particular point in the patient's clinical course and may not fully capture long-term lipid exposure. The mean value of 135.49 mg/dL should therefore be understood as a description of the observed population rather than evidence that triglyceride levels were responsible for the occurrence of CHD. The variation between 61 and 180 mg/dL further indicates that patients with the same clinical diagnosis may have substantially different lipid characteristics. This consideration strengthens the rationale for examining composite lipid indicators such as the TG/HDL ratio in the following subsection.

HDL Levels in Patients with Coronary Heart Disease

High-density lipoprotein (HDL) is an important component of lipid metabolism because its biological functions extend beyond its role in transporting cholesterol. HDL participates in cholesterol transport and has been associated with several processes relevant to vascular homeostasis, although the concentration of HDL alone does not fully represent its functional capacity. Alterations in HDL characteristics may occur in metabolic disorders and cardiovascular disease, making HDL assessment relevant when describing the lipid profile of patients with CHD. Zhang and van der Vorst (2024) explain that HDL can undergo structural and functional modifications under metabolic conditions such as type 2 diabetes, potentially affecting its protective biological properties. The relationship between HDL and cardiovascular health therefore involves both quantitative and qualitative aspects. Measurement of HDL concentration remains useful for clinical characterization, particularly when interpreted together with triglycerides and other lipid parameters.

The descriptive results in this study show that the recorded HDL concentration had a mean of 50.53 mg/dL and a standard deviation of 18.732 mg/dL. The median HDL concentration was 45.00 mg/dL, with values ranging from 24 to 93 mg/dL. The difference between the mean and median indicates variation in HDL concentrations among the observed records. The relatively wide range also suggests that patients with CHD did not present with an identical HDL profile. HDL concentrations may vary according to metabolic characteristics, nutritional factors, underlying disease conditions, and other patient-level factors. Anata and Yasmin (2025) similarly demonstrated variation in lipid-profile parameters among Indonesian patients with CHD, highlighting the heterogeneous nature of lipid characteristics in clinical populations. The observed HDL values should consequently be interpreted as part of the broader lipid profile rather than as an isolated indicator of cardiovascular status.

Table 3. Description of HDL Levels

Variable	n	Mean (mg/dL)	SD	Median (mg/dL)	Minimum (mg/dL)	Maximum (mg/dL)
HDL	6	50.53	18.732	45.00	24	93

Table 3 demonstrates that the mean HDL concentration was 50.53 mg/dL, while the median was somewhat lower at 45.00 mg/dL. The standard deviation of 18.732 mg/dL indicates considerable dispersion around the mean, reflecting substantial differences in HDL concentrations within the recorded observations. The minimum value of 24 mg/dL and maximum value of 93 mg/dL further illustrate the variability of HDL measurements in the dataset. Such variation is relevant because HDL concentration can represent different metabolic conditions across patients, particularly when considered alongside triglyceride concentrations. Goldberg (2022) notes that dyslipidemia in diabetes may involve changes across multiple lipid fractions rather than abnormalities in only one parameter. Interpretation

of the HDL findings should therefore incorporate the triglyceride values presented previously and the TG/HDL ratio examined in the subsequent analysis.

HDL metabolism is closely connected with the movement and processing of lipids throughout the body. HDL participates in reverse cholesterol transport, while its composition and functionality can be altered by metabolic disturbances. Zhang and van der Vorst (2024) describe how HDL modifications in type 2 diabetes may affect its functional properties and potentially alter its cardiovascular relevance. Insulin resistance may also contribute to broader disturbances in lipid metabolism, producing changes in triglycerides and HDL that are commonly considered together in metabolic assessment (Kosmas et al., 2023). This metabolic relationship explains why the clinical interpretation of HDL is strengthened when it is evaluated in combination with triglyceride concentrations. Baneu et al. (2024) reported that the TG/HDL ratio can serve as a surrogate marker of insulin resistance, emphasizing the interconnected nature of these two lipid parameters. The HDL concentration observed in the present dataset therefore provides an important component for understanding the metabolic profile represented by the TG/HDL ratio.

Variation in HDL may also have implications for the interpretation of coronary atherosclerotic risk. HDL quantity alone does not necessarily capture the functional properties of the lipoprotein, particularly under conditions involving oxidative or metabolic modification. Zhang and van der Vorst (2024) indicate that changes in the HDL particle can influence its biological functions, demonstrating why concentration-based interpretation should be approached within a broader metabolic framework. Clinical evidence has also examined lipid ratios rather than isolated HDL concentrations when evaluating coronary disease characteristics. Susila et al. (2025) reported relationships involving the TG/HDL ratio and LDL/HDL ratio in patients with coronary artery disease, illustrating the relevance of combined lipid indicators in cardiovascular assessment. Hashmi et al. (2024) likewise examined the LDL/HDL ratio in relation to coronary lesion severity among NSTEMI patients in Medan. These findings provide a clinical context for interpreting HDL as one component of a multidimensional lipid profile rather than as an independent determinant of coronary disease.

The observed HDL concentrations should also be considered in relation to factors that may modify lipid metabolism and cardiovascular risk. Dietary composition can influence circulating lipid concentrations, while the effects of specific dietary fats depend on the type and overall dietary pattern (Sacks et al., 2017). Hypothyroidism is another condition associated with alterations in lipid metabolism and can influence circulating lipoprotein concentrations (Liu & Peng, 2022). These factors demonstrate that differences in HDL among patients with CHD may reflect multiple biological and clinical processes rather than a single underlying mechanism. The range of 24–93 mg/dL in the present data is consistent with substantial individual variation, although the available descriptive analysis cannot determine which factors accounted for that variation. The HDL findings consequently provide an important basis for interpreting the TG/HDL ratio, because changes in either component can modify the resulting ratio. Examination of the ratio in the next subsection can offer a more integrated assessment of the relationship between triglyceride and HDL concentrations. Such an approach is particularly relevant because cardiovascular lipid abnormalities frequently involve interactions among several lipid fractions rather than isolated changes in one parameter.

LDL Levels and LDL Categories in Patients with Coronary Heart Disease

Low-density lipoprotein (LDL) cholesterol is a central lipid parameter in the assessment of cardiovascular risk because circulating LDL particles can contribute to cholesterol accumulation within the arterial wall. Persistent exposure to elevated LDL concentrations is closely related to the development and progression of atherosclerotic cardiovascular disease. The clinical importance of LDL is reflected in cholesterol-management guidelines that emphasize appropriate assessment and reduction of atherogenic lipoproteins in individuals at cardiovascular risk (Grundy et al., 2019). Among patients who already have coronary heart disease (CHD), LDL assessment is particularly relevant because coronary atherosclerosis represents an established manifestation of atherosclerotic cardiovascular disease. LDL concentrations, however, should be interpreted within the broader clinical and metabolic characteristics of each patient. Differences in disease severity and lipid characteristics can produce substantial variation in LDL measurements among patients with CHD.

The present study included 96 patients with CHD whose LDL measurements were available in the medical records. The mean LDL concentration was 140.20 mg/dL, with a standard deviation of

38.317 mg/dL. The median LDL concentration was 129.00 mg/dL, while the recorded values ranged from 54 to 226 mg/dL. The difference between the mean and median indicates that several observations with relatively higher LDL concentrations contributed to the overall average. The range of 172 mg/dL also demonstrates considerable heterogeneity in LDL concentrations across the study population. Tanaka et al. (2023) similarly examined differences in LDL cholesterol among patients with different levels of coronary artery disease severity, demonstrating the clinical relevance of LDL variation in patients with established coronary disease. These findings indicate that the LDL profile of patients with CHD cannot be characterized adequately through a single representative value alone.

Table 4. Description of LDL Levels

Variable	n	Mean (mg/dL)	SD	Median (mg/dL)	Minimum (mg/dL)	Maximum (mg/dL)
LDL	96	140.20	38.317	129.00	54	226

Table 4 shows that the average LDL concentration was 140.20 mg/dL, whereas the median was 129.00 mg/dL. The median being lower than the mean suggests that the higher LDL observations had an appreciable influence on the average value. The standard deviation of 38.317 mg/dL further indicates substantial dispersion in LDL concentrations among the patients. Such variability is clinically relevant because patients with the same CHD diagnosis may have different levels of exposure to atherogenic lipoproteins. Anata and Yasmin (2025) also reported lipid-profile characteristics among Indonesian CHD patients, supporting the relevance of evaluating individual lipid parameters within this clinical population. The minimum and maximum values in Table 4 indicate that LDL concentrations extended from relatively low to markedly elevated levels, providing a heterogeneous basis for subsequent categorical analysis.

The categorical distribution provides another perspective on the LDL profile of the study population. Using the study-defined cut-off, 50 patients (52.1%) were classified as having normal LDL concentrations, while 46 patients (47.9%) were classified as having high LDL concentrations. The relatively close proportions between the two categories indicate that high LDL was present in a substantial proportion of the CHD patients despite the overall mean being only moderately above the selected threshold. This pattern also demonstrates why mean values alone may conceal clinically meaningful differences between individual patients. The presence of high LDL among nearly half of the sample is consistent with the established role of LDL as an important modifiable component of atherosclerotic cardiovascular risk (Grundy et al., 2019). The distribution should nevertheless be interpreted in relation to treatment status and other clinical characteristics because LDL concentrations may be influenced by pharmacological and metabolic factors. Categorization therefore provides a practical framework for examining whether LDL status is associated with the TG/HDL ratio in the subsequent analysis.

Table 5. Distribution of LDL Level Categories

LDL Category	n	Percentage (%)
Normal	50	52.1
High	46	47.9
Total	96	100.0

The distribution in Table 5 indicates that 52.1% of patients were classified as having normal LDL concentrations and 47.9% as having high LDL concentrations. The difference of only 4.2 percentage points between the two groups indicates that neither category overwhelmingly dominated the study population. This relatively balanced distribution is useful for subsequent analysis because both LDL categories contain a substantial number of observations. The finding also illustrates that a CHD diagnosis does not necessarily correspond to uniformly elevated LDL concentrations at the time of measurement. Munita et al. (2025) demonstrated the relevance of non-traditional lipid parameters in patients with obstructive coronary artery disease, indicating that coronary disease characteristics may

involve a broader lipid profile than LDL alone. Consequently, the proportion of patients with normal LDL in this study should not be interpreted as evidence of an absence of atherosclerotic lipid risk, particularly because CHD is a multifactorial condition involving several metabolic and vascular processes.

Several biological and clinical factors may contribute to differences in LDL concentrations among patients with CHD. Hypothyroidism, for example, can disrupt lipid metabolism and is associated with changes in circulating cholesterol and lipoprotein concentrations (Liu & Peng, 2022). Nephrotic syndrome can also produce significant disturbances in lipid metabolism through mechanisms involving altered hepatic lipoprotein production and impaired lipid clearance (Vaziri, 2016). Familial hypercholesterolemia represents another important condition that can produce persistently elevated LDL concentrations and substantially increase lifetime exposure to atherogenic lipoproteins (Tokgozoglu & Kayikcioglu, 2021). Chronic liver disease may produce different patterns of dyslipidemia depending on the underlying etiology and stage of hepatic dysfunction (Unger et al., 2019). These conditions demonstrate that LDL concentration is shaped by multiple physiological and pathological processes rather than by coronary disease status alone. Treatment exposure is also relevant because patients receiving lipid-lowering therapy may have lower LDL concentrations at the time of medical-record assessment than their untreated baseline levels.

The LDL findings in this study can also be considered in relation to the progression and characteristics of coronary atherosclerosis. Atherosclerotic plaque development involves interactions between circulating lipoproteins, endothelial characteristics, inflammatory processes, and local vascular conditions rather than a single lipid measurement (Siasos et al., 2022). Endothelial shear stress has also been associated with differences in coronary plaque progression and composition, indicating that local vascular factors can influence the manifestation of atherosclerotic disease (Candrea et al., 2024). Indonesian evidence has further reported associations between metabolic risk factors and CHD progression, reinforcing the multifactorial nature of coronary disease (Safrizal et al., 2025). The LDL distribution observed in this study should therefore be understood as one component of a complex cardiovascular risk profile. The relatively similar proportions of normal and high LDL categories provide an appropriate basis for investigating whether another lipid-derived indicator, specifically the TG/HDL ratio, differs according to LDL category. Such an analysis is presented in the following subsection through the distribution of TG/HDL categories and the statistical test examining their relationship with LDL status.

Triglyceride-to-HDL Ratio and Its Relationship with LDL Levels

The triglyceride-to-HDL ratio (TG/HDL) provides a combined indicator that integrates two lipid parameters with interconnected metabolic characteristics. Unlike the separate assessment of triglycerides or HDL, this ratio reflects the relative balance between circulating triglyceride and HDL concentrations. Its clinical relevance has been examined particularly in relation to insulin resistance, metabolic syndrome, and cardiovascular risk. Baneu et al. (2024) identified the TG/HDL ratio as a surrogate biomarker for insulin resistance, supporting its use as an accessible indicator of metabolic disturbance. Yeh et al. (2019) similarly reported that an elevated TG/HDL ratio was associated with insulin resistance in a middle-aged and elderly Taiwanese population. These findings provide a biological basis for examining the TG/HDL ratio among patients with established CHD and for considering its relationship with other lipid parameters.

The descriptive analysis showed that the mean TG/HDL ratio among the 96 patients was 2.912, with a standard deviation of 0.899. The median ratio was 2.841, while the minimum and maximum values were 1.463 and 6.000, respectively. The relatively close mean and median indicate that the central tendency of the ratio was reasonably consistent across the observed data. At the same time, the range demonstrates substantial variation in the relative relationship between triglyceride and HDL concentrations among individual patients. Based on the cut-off of 2.197, 27 patients (28.1%) were classified as having a normal TG/HDL ratio, whereas 69 patients (71.9%) were classified as having a high ratio. This distribution indicates that the high-ratio category represented a considerable proportion of the CHD population. The predominance of an elevated TG/HDL ratio is clinically relevant because this indicator may capture metabolic abnormalities that are not fully apparent from triglyceride or HDL concentrations considered separately.

Table 6. Description of Triglyceride-to-HDL Ratio

Variable	n	Mean	SD	Median	Minimum	Maximum
TG/HDL Ratio	96	2.912	0.899	2.841	1.463	6.000

Table 6 illustrates that the observed TG/HDL ratio extended from 1.463 to 6.000, indicating considerable interindividual variation. The mean ratio of 2.912 was above the study cut-off of 2.197, while the median of 2.841 showed a similar pattern. The high proportion of patients classified in the elevated category suggests that an unfavorable triglyceride-to-HDL balance was common in this CHD population. The ratio should not, however, be interpreted as a direct measure of coronary lesion severity because its value reflects the interaction between two circulating lipid concentrations rather than anatomical assessment of the coronary arteries. Hayat et al. (2024) reported the relevance of the TG/HDL ratio to cardiovascular risk among individuals with metabolic syndrome risk, supporting its interpretation as a metabolic rather than purely anatomical indicator. Sinaga et al. (2023) also found an association between TG/HDL ratio and coronary lesion severity in patients with acute myocardial infarction, although differences in study population and clinical design should be considered when comparing those findings with the present descriptive results.

The high prevalence of the TG/HDL category may be related to the metabolic relationship between triglyceride accumulation and reduced HDL availability or functionality. Insulin resistance can alter adipose tissue lipid mobilization and increase the delivery of fatty acids to the liver, contributing to changes in triglyceride metabolism (Cho et al., 2023). The metabolic disturbance associated with insulin resistance can also produce an atherogenic lipid pattern characterized by elevated triglyceride concentrations and changes in HDL metabolism (Kosmas et al., 2023). HDL itself may undergo structural and functional modifications under metabolic stress, meaning that its concentration does not necessarily represent all aspects of its biological activity (Zhang & van der Vorst, 2024). The resulting TG/HDL ratio may consequently capture part of the metabolic imbalance occurring in patients with cardiovascular disease. Yeh et al. (2019) demonstrated the usefulness of an elevated TG/HDL ratio as an indicator of insulin resistance, while Baneu et al. (2024) provided more recent evidence supporting its surrogate role. The predominance of the high-ratio category in this study is therefore consistent with the possibility that metabolic disturbances were common among the observed CHD patients.

The distribution of TG/HDL categories according to LDL status provides a more specific assessment of the relationship between these lipid indicators. Among the 27 patients with a normal TG/HDL ratio, 17 patients (63.0%) had normal LDL and 10 patients (37.0%) had high LDL. Among the 69 patients with a high TG/HDL ratio, 33 patients (47.8%) had normal LDL and 36 patients (52.2%) had high LDL. The proportion of high LDL was consequently greater in the high TG/HDL category than in the normal TG/HDL category. However, the difference between the categories was not sufficiently large to establish a statistically significant association in this sample. The observed pattern is nevertheless relevant because it suggests that an elevated TG/HDL ratio and high LDL can occur together in some patients, while a substantial number of patients with an elevated TG/HDL ratio still had normal LDL. This pattern supports the concept that different lipid indicators may capture partially distinct aspects of cardiovascular metabolic risk.

Table 7. Distribution of TG/HDL Ratio Categories According to LDL Level

TG/HDL Category	LDL Normal n (%)	LDL High n (%)	Total n (%)
Normal	17 (63.0)	10 (37.0)	27 (100.0)
High	33 (47.8)	36 (52.2)	69 (100.0)
Total	50 (52.1)	46 (47.9)	96 (100.0)

Table 7 shows that patients with a high TG/HDL ratio had a somewhat greater proportion of high LDL than patients with a normal ratio, with proportions of 52.2% and 37.0%, respectively. The difference indicates a descriptive tendency toward concurrent elevation of the two lipid indicators, but the cross-tabulation alone cannot determine whether this pattern represents a statistically meaningful relationship. The Pearson Chi-Square test was therefore conducted to formally assess the association

between the categorical TG/HDL ratio and LDL status. The test produced a chi-square value of 1.782 with one degree of freedom and a p-value of 0.182. Since the p-value exceeded the 0.05 significance level, the null hypothesis was not rejected, indicating that no statistically significant association was identified between TG/HDL category and LDL category in the observed CHD patients. This result does not mean that TG/HDL and LDL are biologically unrelated, but rather that the observed categorical relationship was insufficient to demonstrate statistical significance in this particular sample. The finding is also consistent with the broader understanding that coronary lipid abnormalities involve multiple metabolic pathways rather than a single uniform lipid pattern.

Table 8. Chi-Square Test of the Relationship Between TG/HDL Ratio and LDL Levels

Test	Value	df	p-value	Interpretation
Pearson Chi-Square	1.782	1	0.182	Not significant

The nonsignificant result in Table 8 can be interpreted in light of the multifactorial determinants of LDL metabolism and coronary atherosclerosis. LDL concentrations may be affected by endocrine conditions such as hypothyroidism, which can alter cholesterol synthesis, clearance, and lipoprotein metabolism (Su et al., 2022). Familial hypercholesterolemia can also produce markedly elevated LDL through inherited disturbances in lipoprotein clearance, independently of the TG/HDL profile (Tokgozoglu & Kayikcioglu, 2021). Differences in chronic liver disease can further produce heterogeneous dyslipidemia because hepatic function is closely connected with lipid synthesis and clearance (Unger et al., 2019). These factors illustrate why a high TG/HDL ratio does not necessarily coincide with high LDL in every patient. The findings are also compatible with evidence that coronary atherosclerosis is shaped by multiple interacting mechanisms, including lipid exposure and local vascular conditions (Candreva et al., 2024). The absence of a statistically significant association in this dataset should therefore be interpreted as a characteristic of the observed sample rather than as evidence that either lipid parameter lacks clinical relevance.

From a clinical perspective, the results demonstrate the importance of considering lipid parameters in combination rather than assuming that one abnormal indicator will consistently accompany another. The predominance of a high TG/HDL ratio alongside the relatively balanced distribution of normal and high LDL suggests that these measures may identify different dimensions of metabolic and cardiovascular risk. Munita et al. (2025) similarly highlighted the relevance of non-traditional lipid profiles in patients with obstructive coronary artery disease, supporting broader lipid characterization in coronary populations. Susila et al. (2025) also examined TG/HDL and LDL/HDL ratios in relation to coronary artery disease, reinforcing the value of lipid ratios as complementary indicators. The current findings should nevertheless be interpreted within the limitations of a cross-sectional medical-record design, in which lipid measurements represent clinical observations at specific points rather than long-term exposure. The absence of statistical significance may also be influenced by sample size, categorical transformation of continuous lipid measurements, treatment exposure, and unmeasured patient characteristics. The TG/HDL ratio therefore remains informative as a descriptive metabolic indicator in this population, while its lack of a significant categorical association with LDL indicates that the two measures should not be treated as interchangeable markers of lipid status.

CONCLUSION

The findings show that the lipid profile of patients with coronary heart disease at Royal Prima Hospital during 2024–2026 exhibited considerable variation across triglyceride, HDL, and LDL parameters. The mean triglyceride level was 135.49 mg/dL, with values ranging from 61 to 180 mg/dL, indicating heterogeneous triglyceride characteristics among the 96 patients. The mean HDL level was 50.53 mg/dL, with a range of 24–93 mg/dL, demonstrating variation in HDL concentrations within the observed population. The mean LDL level was 140.20 mg/dL, while the median was 129.00 mg/dL and the observed range was 54–226 mg/dL. Based on the study classification, 50 patients (52.1%) had normal LDL levels, whereas 46 patients (47.9%) had high LDL levels. In contrast, the TG/HDL ratio was predominantly classified as high, with 69 patients (71.9%) exceeding the cut-off of 2.197, while 27 patients (28.1%) were categorized as normal. This distribution indicates that an elevated TG/HDL ratio was a prominent characteristic among the CHD patients included in the study.

The cross-tabulation showed that among patients with a normal TG/HDL ratio, 17 (63.0%) had normal LDL levels and 10 (37.0%) had high LDL levels. Among patients with a high TG/HDL ratio, 33 (47.8%) had normal LDL levels and 36 (52.2%) had high LDL levels. Although the proportion of high LDL was greater among patients with a high TG/HDL ratio, the observed difference did not reach statistical significance. Pearson Chi-Square analysis produced a χ^2 value of 1.782 with 1 degree of freedom and a p-value of 0.182. Since the p-value was greater than 0.05, the null hypothesis was retained, indicating that no statistically significant association was identified between TG/HDL ratio category and LDL category among the studied CHD patients. The finding suggests that TG/HDL and LDL should be regarded as complementary lipid indicators rather than interchangeable measures of lipid status in this population. Further studies involving larger samples, additional clinical variables, treatment status, and continuous rather than categorical lipid measurements may provide a more comprehensive understanding of the relationship between these parameters in patients with coronary heart disease.

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